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LIMITS OF BIOLOGICAL EXPERIMENTS.[1]

BY DR. MANLY MILES.

The proposition to test theories in evolution by direct experiments on living organisms which has been favorably noticed, and the numerous futile feeding experiments that have been made at the Government experiment stations, raise the question as to the probable limits of direct experimental methods in dealing with biological problems. The "whirligig of time," in connection with a certain uniformity in the outcome of the modified processes of nutrition and reproduction in a number of individuals, must be regarded as essential elements in bringing about the gradual aggregation and perpetuation of the minute changes in living organisms which we recognize as processes of evolution.

Aside from these significant factors, which cannot be neglected, the exceedingly complex conditions involved in all biological activities appear to be formidable difficulties to overcome in attempting a direct experimental verification of theories relating to the various agencies concerned in evolution, or, in determining the relative value of foods in the processes of nutrition.

Intelligent breeders of domestic animals have no doubts in regard to the heredity of acquired characters, which, in the light of their experience, they look upon as a fundamental principle in stock breeding and one of the most important factors in the available means of improvement. The direct proof of this principle by experimental methods must, however, be difficult, if not impossible, notwithstanding the cumulative and apparently conclusive evidence presented in the history of the improved breeds, and the experience of successful breeders who have recognized its importance in the improvement of their animals.

The dominant influence of other known biological factors may completely obscure well marked special characters that have undoubtedly been inherited, as in the familiar facts of atavism, and they must effectually prevent the detection of the initial stages in the development of any new characters under investigation, which may in fact have been potentially transmitted for a number of generations.

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[1] (Abstract of a paper read at the Brooklyn meeting A. A. A. S., Aug., 1894).

Reversion, prepotency, and the influence of a previous impregnation, are conspicuous obstacles in the way of tracing the immediate, or incipient indications of the inheritance of any particular acquired character which it may be desirable to perpetuate by judicious selections.

In many of the arguments relating to the heredity of acquired characters it appears to be tacitly assumed that each particular character is transmitted as an entity, regardless of its interdependent relations to other parts of the organism, and especially with the specific functional adaptations of the organs of nutrition which have made its development possible.

As pointed out in a paper read in Section F, at the Rochester meeting of the Am. Ass. Adv. Sci., physiological changes in the organism must precede any manifest modification of structural characters, and the transmission of a morphological peculiarity must, therefore, involve the transmission of the functional activities through which it has its origin. It was also shown that a habit or bias of the nutritive processes in a certain direction, may be transmitted for a number of generations without any visible morphological evidence of its existence, and that, in the lapse of time, it may lead to the development of obvious structural changes that are recognized as new characters. Experimental methods in biology are too crude to admit of a recognition of these preliminary steps in the development of new characters, which must be taken into account in making a satisfactory verification of any of the processes of evolution.

The artificial conditions to which our domesticated plants and animals are subjected, intensifies their susceptibility to variation, and there appears to be a constant tendency to reversion when any unfavorable conditions prevail in their treatment. Under ordinary management, repeated systematic selections are necessary in order to maintain the highest development of the most desirable characters, and a considerable number of individuals will be required to make any marked improvement in special qualities, as all do not respond alike to the artificial modifying conditions of their environment.

There are also individuals that retain a tendency to the prepotent transmission of the old race characters, notwithstanding the high development of the particular improved characters they possess, and a pedigree, showing that all known ancestors have had the desired qualities, is looked upon as a valuable index of the dominant inherited characters.

Even the best established breeds fail to exhibit the uniformity in their general characteristics which prevails in wild species that have been subjected to the more rigorous and discriminating processes of natural selection. The methods of artificial selection in the breeding of animals, are lacking in the inexorable consistency and comprehensiveness that characterize natural selection. The breeder of improved animals is unable to perceive all of their innate and acquired physiological tendencies, and his selections are made with reference only to the most obvious peculiarities, or qualities, and he overlooks and neglects many of the factors concerned in determining the correlated relations of the sum of their characters.

Feeding experiments to ascertain the relative nutritive value of different articles of food and the advantages of different methods of feeding, or, to determine the relative merits of different breeds, are especially liable to mislead, from the complexity of the problems presented—the small number of facts under observation—and the practical difficulties in the way of tracing the obscure relations of the most significant factors in the phenomena under investigation, to say nothing of the fallacious and obsolete chemical theories of nutrition that are too often adopted in a popular discussion of the results.

It is not my purpose to enter upon an exhaustive discussion of the limits of experimental biology, but to point out some of the practical difficulties involved in its methods and results. Without further reference to particulars, it must be evident that biological activities have such complex interdependent relations, that theories relating to evolution cannot all be verified, or practical problems in nutrition satisfactorily solved, by direct experimental methods.